If we watch the phenomenon carefully, we observe that at each systole of the lymphatic heart, the vein is drawn backwards as a whole, and that at each diastole the vein retracts into its former position. This rhythmical backward and forward movement of the vein longways is evidently owing to its being closely bound to the anterior part of the heart so as to be dragged by it in its contractions. The nature of the bond of connection appears to be this: The lymphatic heart is embraced anteriorly by the veins, which by their inosculation form the trunk in question, viz., on the outer border several small veins which are bound to the heart by its capsule of cellular tissue; and on the inner border, a large vein which is a continuation upwards and behind the large transverse process of the third dorsal vertebra of that vein into which the lymphatic heart really propels the lymph in the manner I have described. And now, in conclusion, let me express the hope that I have made it clear to demonstration: 1st, that the movements exhibited by the jugular vein of the frog, on either side, though synchronous with the action of the anterior lymphatic heart, are not pulsations produced by the propulsion of lymph into it, and that, in fact, the heart does not open into the said vein at all; and 2dly, that the vein into which the lymph is really pumped is seated within the thorax at the posterior border of the heart, and that the propulsion of the lymph into it causes no distension, and consequently no pulsation.

ARTICLE VII.

EMPYEMA AND ITS TREATMENT.[1] By F. E. MARTINDALE, A.M., M.D., of Port Richmond, N. Y., Consulting Surgeon to the Child's Nursery and Hospital, Port Richmond.

I DO not propose in the following paper to analyze the several factors that enter into the causation of empyema as a grave pathological condition, nor advance any new theory as to why pus should at any time be effused into the pleura rather than serum or lymph, during the course ot an exceptionally severe pleuritis. It is enough for us to know, for the purpose hereinafter set forth, that such is the case, and that when it is, operative measures become an absolute necessity in the interest of the patient and his permanent recovery.

I purpose, however, viewing this pathological condition, or result, solely in connection with the several operative methods that have been proposed for its radical treatment in the past, and to illustrate, by a case in point, that method alone, which to my mind seems entitled to be regarded as a positively radical treatment, and which in a large majority of cases promises an absolute and certain recovery to those operated upon.

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[1] A paper read before the Richmond County Medical Society, New York, May 4, 1881.

The genesis of these or co-ordinate measures for the removal of effusions from within the thoracic walls dates back even to the time of Hippocrates. It may reasonably be presumed that accumulations of pus within the pleura were evacuated spontaneously in individual cases, then as now, and that where there were external evidences of its presence as shown by localized inflammations and pointing, the ancient surgeons incised the supposed abscess and thus, imperfectly no doubt, evacuated the contents of the pleura; in fact, there can be no question as to this operation having been occasionally performed during the time of Galen with more or less favourable results. At a much later period we learn that as physicians became more and more distinctly separated from surgeons, the spirit of opposition to operative interference arose, and this antagonism between the two branches of the profession may be recognized, even to as late a date as the year 1836, by reference to the Transactions of the Paris Academy, on that subject, for that year. In fact, it has only been in quite modern times that clear indications have been recognized, and precise methods adopted for operative interference in these cases, as exemplified in the more modern application of aspiration to their treatment.

This latter method was, for a considerable length of time, regarded as the *ne plus ultra* of surgical resource, and one that guaranteed more successful results in the removal of the purulent contents of the pleura than had before been obtained, but it failed in this, that it did not do it effectually enough to alter or modify the process of the conversion of lymph into pus by the secreting membrane of the pleura, and hence its present disuse in those cases. Laennec, Trousseau, Reybard, and still later Marrote, well known as advanced thinkers among the leading French physicians of their day, did not hesitate to advise and practise the method of puncturing pleuritic effusions whatever their character, as can be seen by reference to papers published in the Bulletin of the Academy of Med., Paris, 1846, and the Transactions of the Society of the Hospitals of Paris, 1864. Trousseau regarded the operation for paracentesis as an exceedingly grave one even in sero-fibrinous effusions, and declares it should be had recourse to only "when there is danger to life from immediate suffocation, or when the effusion is very large;" Marrote, in the paper read before the Society of the Hospitals of Paris, '64, and just referred to, is the first to make a clear distinction between the treatment of sero-fibrinous and purulent effusions, and declares "that the radical operation of incision is the only one in purulent effusions that is at all likely to lead to a cure." Bowditch was undoubtedly the first to introduce aspiration into practice as a reliable therapeutic agent, and a paper published by him in the *American Journal of the Medical Sciences*, as early as 1852, advises its application to all thoracic effusions, and in a later one, published in the same Journal in

1864, denies that any ill results are likely to follow, or that purulent effusions cannot be effectually withdrawn through the capillary tubes provided for that operation. Fraentzel, an eminent German author, however, in his article on "Pleuritis," in Ziemssen's Cyclopædia, declares that "they would certainly give the preference to the new method of operating by single incision, with canula, and washing the pleura, who have seen as I have, as many as eighteen cases, in which the then radical operation by aspiration had been performed, with only two recoveries, and one of these after a tedious course of a year and three-quarters with serious deformity of the whole thorax." It will thus be seen that the operative treatment for purulent effusions is essentially different from that for sero-fibrinous, and the sooner after the diagnosis has been rendered positive by the aid of the hypodermic syringe, the purulent contents of the pleura are thoroughly evacuated, the greater certainty will there be of a favourable result. By reference to the "Guy's Hospital Reports" of 1877, with respect to the treatment of empyema, we learn from Dr. Goodhart's tabular analysis of 77 cases that fifteen were subjected to no operative treatment; of which two only, both children, aged five and two and a-half years, recovered; in eleven of the remainder the empyema pointed and discharged spontaneously, or was incised; of these, only two made good recoveries, the remainder under the radical method of treatment got well.

Drs. Barlow and Parker, in their notes on "Pleuritic Effusions in Childhood," observe with respect to spontaneous evacuation by external opening that "our experience does not supply us with a single good result." In my own practice, the single incision without drainage or washing has been successful in the case of a young patient aged five years, who is now living and in good health four years after the operation.

Of the few cases that have been operated upon among adults within the limits of my own knowledge and that of most of my medical acquaintances in Richmond County, or that have discharged spontaneously under their medical supervision, not one, so far as I can learn, made a permanent recovery. The great mortality resulting from the method by aspiration, and in fact from that by single incision as well, without antiseptic treatment, has undoubtedly been largely due, 1st, to the decomposing influence of infected air upon the purulent contents of the pleura; 2d, to failure in thoroughly evacuating these contents; and 3d, the non-use of strong carbolized spray (1 to 40) at the subsequent dressings, as well as during the operation. Powell, in his "Treatise on Consumption and Diseases of the Lungs," 1878, in referring to the operative treatment then recommended for empyema, observes, page 244: "As it is clear that we cannot empty the pleura even in recent cases without admitting air in place of fluid, we must adopt one of three methods: 1st, either to disinfect the air admitted into the pleura and having inserted a canula to close the wound with antiseptic dressings, to be renewed with the same precautions every three or four days; or 2d, to make a double opening and introduce a drainage-tube, so as to permit the escape of pus as rapidly as formed; or 3d, to make a single incision or free opening, and insert a tube through which the pleura can be daily washed out with some disinfecting fluid." Of the three methods he says the first is to be preferred.

Dr. Gross in his "System of Surgery," in referring to the fact of the drainage-tube having lately been recommended, for the treatment of empyema, says, "it should not be encouraged, as it is both harsh and dangerous."

From the foregoing, it can readily be seen that a great diversity of opinions has, even within recent years, been entertained, as well as a variety of operative methods adopted, for emptying the contents of the pleura in the formidable complication of pleuritis we are now considering. The one great object sought has been to secure this result without the admission of air into the pleural cavity, or if this could not be avoided, then to so deprive it of its infecting qualities as to render it practically harmless. In fact, the fears of early operators, of the probable fatal effects of air reaching the cavity of the pleura, led them to perform the operation by single incision, for empyema, in a warm bath, that water rather than air should replace the pus evacuated. Setting aside the possibility of collapse, or paralysis of the heart, from this method, it is difficult to perceive what possible benefit could accrue from the substitution.

The following interesting case will show the results of two operations for the radical relief of empyema, the first being the introduction of the canula and application of the siphon, which failed, and the other by the anterior and posterior incisions and drainage-tube, as follows:—

Frank F., aged 20 years, came under my observation on the 4th of February last. His history developed the fact of his mother having died of "lung trouble," presumably "caseous pneumonia," also a sister of phthisis. Had been ailing for a week, supposed to be with a bad cold. Temperature taken at date of visit registered 106°; pulse 130; respirations 50. The physical signs indicated pleuro-pneumonia of the left side. The usual treatment was adopted, and, it being absolutely necessary to allay the intense pain, a hypodermic injection of morphia was administered.

Feb. 8th. Patient since last record has suffered severely with pain and dyspnœa when not fully under the influence of morphia. General appearance distressed. Pulse rapid and feeble. Temperature 104°. Respiration purely costal. Expectoration viscid, and of the brickdust variety. Physical signs presented dulness throughout the left side to mid-sternum. Heart's apex beneath the left border of the sternum. Tubular breathing heard in scapular and clavicular regions. There was clearly considerable effusion of some kind in the left pleural sac, but no diaphoresis had as yet led me to suspect the existence of pus. Very little change in the character of the symptoms occurred, if we may except a slight fall in the temperature and a gradual subsidence of the pain and dyspnœa up to the 12th of February, when the thermometer registered 102°, pulse 120, and respirations 46. At this date the dulness extended to near the lower border of the clavicle, the patient being restless and despondent.

On the 20th, I introduced a hypodermic needle into the pleura, and withdrew a portion of its contents, which proved to be of a sero-purulent character; but, to render the diagnosis a positive one, I took the fluid to my colleague, Dr. Wm. C. Walser, to verify it by a microscopical examination if it were correct, and through his kindness, demonstrated unequivocally the presence of pus globules, and the certainty of the case being one of empyema. The temperature at this date ranged from 100.5° in the morning to 102.5° in the evening. Pulse from 110 to 130. Respiration 46. Heart's apex beneath the sternum, and dulness extending to above the clavicle. Decubitus on the right side. Patient gradually emaciating, and his appetite failing, I resolved on the 27th Feb. to puncture the pleura, and accordingly, Dr. E. D. Coonley being present and assisting, I performed paracentesis, and applying the siphon, previously filled with water, and immersed at its lower extremity in the same liquid, withdrew about a pint of pus, when, it ceasing to flow, we were obliged to desist, and the canula was withdrawn, carbolized cotton being applied over the point of puncture. Very slight variations either of temperature, pulse, or respiration, occurred from this date to March 6th. There were moderate night-sweats, and well-marked hectic. The heart was now beating about two inches to the right of the sternum. Comparative measurements of right and left side showed an increase of two inches in favour of the left. Intercostal spaces obliterated, and a view of the patient anteriorly or posteriorly shows the whole of the left side of the thorax bulging. I now decided to perform one of the three radical operations suggested by Powell for the removal of the purulent contents of the pleura, and, it appearing to me that the one that would afford the fullest and freest exit to the contained matter gave promise of the best results, I decided upon the operation by anterior and posterior incisions and the drainage-tube, under a full stream of carbolized spray. Accordingly, on the 8th of March, 2 o'clock P. M., Drs. Wm. C. Walser and E. D. Coonley being present and assisting, and without the use of anæsthetics, save freezing the point of incision, I introduced a scalpel through the intercostal space between the fifth and sixth ribs, about two inches to the left of the nipple, and withdrawing it enlarged the opening with a probe-pointed bistoury to three-quarters of an inch, or sufficiently, at all events, to permit of the ready introduction of the drainage-tube. A full stream of pus being discharged with some force was, after a minute or two, checked by the fingers, and brandy freely administered to the patient, when the operation was resumed by introducing through the wound thus made a long and slightly curved sound, having a small knob on the end, which was carried downwards and backwards to as low a point in the pleura posteriorly as could be reached, and, so manipulating it that the knob of the sound could be distinctly felt in an intercostal space on the back, an incision was made to meet it. This being accomplished, and the opening enlarged as before, the end of the sound was passed through, and about half a yard of drainage tubing, previously rendered antiseptic, and provided with holes cut midway between each extremity, was slipped over the knob and withdrawn with the sound through the two incisions, and the two ends finally tied together outside. This completed the operation, and, after about five pints of pus had thus been withdrawn, the chest was carefully sponged with carbolized water, a sheet of carbolized cotton applied to the entire side, this covered with eight thicknesses of antiseptic gauze, and all held in place with antiseptic gauze rollers, the patient clothed and replaced in bed, and stimulants administered *pro re nata*.

The relief afforded by the withdrawal of this large accumulation of pus, and the consequent removal of pressure upon the heart and right lung, was immediate and effective. The evening temperature after the operation registered 100° ; pulse 96 ; respirations 36.

An opiate being administered the patient slept well. From this date to the 11th, when the dressings were renewed, the lowest record of temperature was 99° ; pulse 92 ; respirations 36. On the morning of the 11th he complained of some pain, and had passed a rather restless night, his temperature then registering 101°. The application of fresh dressings under the carbolized spray again brought down the temperature to 98.5°. The dressings removed, as also the bedding, were thoroughly saturated with pus, of which a large quantity drained away during the operation of cleansing. The heart was now beating to the left of the sternum, but not in its normal position. Percussion note tympanitic anteriorly to eighth rib. Slight vesicular breathing heard in the supra-scapular region. Some cough, more particularly at night. Quinia, iron, and cod-liver oil are administered with stimulants, under the use of which the patient's appetite rapidly improves. On the 15th the dressings were again removed, and found as thoroughly saturated as on the last occasion. The same care was exercised in cleansing the wounds, tube, and the patient's body, and in their reapplication as before. The lowest record of temperature since the 11th has been 98° on the 13th ; pulse 84 ; respirations 28.

The emaciation of the patient is now quite marked, and a small bedsore is discovered just above the articulation of the last lumbar vertebra with the sacrum, which is dressed with flexible collodion and tannate of glycerine. Appetite good, and sleeps well under an opium pill. The left wall of the thorax is now sunken, and the percussion note anteriorly less clear than before. Temperature before dressings are reapplied is 99° ; pulse 92 ; respirations 30.

March 23. Temperature since last record has remained daily at 98.5° ; pulse varying from 82 to 96, and respirations when at rest 26 to 36. Dressings renewed with comparatively slight drainage. A very painful abscess forming in right gluteal region ; appetite, however, excellent. A constipated condition of the bowels complained of, which is relieved only by active cathartics.

28th. Dressings renewed. Very slight drainage. Abscess in thigh has discharged spontaneously, with but temporary relief to the pain and immobility of the right leg, as another and larger is forming two inches below. The question arises here, are these the result of local irritation from purulent matters in contact with an abraded surface, or the establishment of metastatic foci of inflammation from absorption of pus into the circulation under strong pressure upon the pleural walls?

We find that for some time back the emaciation of the patient has been gradually becoming more and more marked, until the bones of the pelvis and vertebræ now present an appearance of extreme prominence, which threatens grave possibilities in connection with the decubitus, which is now on the left side. Why, under these conditions, should abscesses have formed on the *right hip* rather than the *left*, assuming the local irritation to have been excentric? Before the final operation the decubitus was on the right side, and consequently the local irritation also, and purulent absorption, if it occurred at all, must have occurred then; but up to that date, and some weeks later, there were no evidences of cellular infiltration in the right hip; some three weeks after the operation, however, when all the purulent contents of the pleura had been thoroughly evacuated, the decubitus being then on the *left* side, acute localized inflammation is set up in the cellular tissue of the *right* hip, and two abscesses follow one after the other. It would seem in this case that the local irritation was applied chiefly to the side opposite that affected.

Heart is now occupying a position to the left of the sternum, but somewhat above its natural position. Percussion note less tympanitic anteriorly, and weak vesicular breathing heard posteriorly to near the lower margin of scapula. General appearance improved. Sleeps now without anodyne or hypnotic. Temperature 98.5°; pulse 86; respirations 26. *April* 4. Dressings renewed, no drainage. Tubing withdrawn and replaced by a horsehair seton eight strands, previously rendered antiseptic. Remaining abscess on thigh lanced, and a large quantity of pus evacuated, and cavity afterward carefully syringed with warm carbolized water. Bedsore entirely healed. Patient is up and able to walk across his bed-room without assistance. Temperature, pulse, and respirations same as previous record. 12*th*. Dressings reapplied, and found slightly soiled with discharge. Patient rode two or three miles with me yesterday, with great satisfaction. Eats heartily and sleeps soundly. No cough. Temperature, pulse, and respirations same as last record. Three strands of the seton removed. 19*th*. Dressings reapplied, those removed slightly soiled with pus. Three more strands of the seton removed. Rode out with me again on Sunday, 17th, with renewed health and strength; weighed yesterday, 18th, and finds a loss of ten pounds on his weight taken just before his illness; his normal weight being 116 pounds, and his weight, as taken on the 18th, being 106 pounds. Judging from his appearance, as presented at or soon after the last operation, and at the last dressing on the 26th of April, there must have been a gain of at least ten or twelve pounds. His chest measurements, as taken on that date, are, circumference, 28½ inches; from median line of sternum to spinous process of vertebra on the plane of the two nipples, left side 13½ inches, right side 15 inches; from crest of ilium to tip of acromion process, left side 13½ inches, right side 16 inches. The calibre of the left half of the thorax, it may thus be seen, is considerably reduced, the ribs approximating, and the shoulder drooping as in Pott's disease.

The remaining strands of the seton were now withdrawn, the discharge of pus being so slight as to suggest the probability of its being due entirely to the presence of the seton itself. The patient's general health is now good, and he daily indulges in out-door exercise, principally on foot, and has added two pounds to his weight since the last dressing a week ago. His temperature taken at this date registered 98.5°; pulse 86; respirations 30. No visits were made from April 26 to May 4, the young man being out visiting, or engaged in some other equally agreeable occupation the greater part of the time. On the latter date the dressings were removed, and both the anterior and posterior wounds found entirely healed. The bandages not being reapplied, a porous buckskin under-shirt was ordered to be worn next the skin, and flannel over this. His weight shows a net gain of four pounds since last dressing. Breathing sound distinct in both scapular and clavicular regions. Temperature 98.5°; pulse 80; respirations 28. Returned to his business May 1.

The anatomical results consequent upon the gradual withdrawal of so large a quantity of purulent fluid from the cavity of the pleura naturally suggest the inquiry as to the cause of this retraction of the chest-walls, and the present relations of the two pleural surfaces in this case. We cannot attribute the former, as some authors have done, to atmospheric pressure, for we have had a perfect equilibrium of atmospheric pressure here since the operation. What, then, has led to the results as stated? The question can better be answered by entering into the consideration of the latter inquiry as to the present relations of the two pleural surfaces. The lung under the pressure of the large effusion into the pleura has been pushed back against the vertebral column, and adhesions have taken place, which, upon the withdrawal of this fluid, prevent its responding fully to the inspiratory effort. A large cavity remained, which nature at once set to work to fill, not with pus or serum, but with rapidly formed granulations upon both surfaces, which becoming aggregated and organized, until finally condensed into a firm living tissue, binds them permanently together, and constitutes the only retracting power that in this has diminished the calibre of the left side of the thorax in every direction, as shown by the measurements already given. We have now a condition present in which auscultation and percussion are practically of but little value in affording us information as to the breathing capacity of the but recently compressed lung. The general indications, however, lead us to the conclusion that a moderate expansion has already taken place, and that this is likely to prove a progressive one under the influence of a regular application of calisthenic rules for chest-development, that will eventually expand the left wall of the thorax at least one-half, and increase its measurements to a degree more nearly approximating the normal.

This case has demanded constant care, unceasing attention, and inexhaustible patience, but the result has freely repaid both the labour expended and the care bestowed in the satisfaction afforded by the knowledge of our having been instrumental in saving a human life that without such aid must inevitably have perished, and the sense of having done our entire duty.